SIGMA XI QUARTERLY

Vol. XV JUNE, 1927 No. 2

ALUMNI NUMBER

Governor Smith on "The State and Scientific Research"

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EDITORIAL COMMENTS

In accordance with the announcement in the March QUARTERLY, the secretary's office began in April the distribution of all Sigma Xi insignia. Duplicate order blanks had previously been issued to chapter secretaries and by May first orders began to come in. It is to be expected that new machinery will not work smoothly when first put into operation, but that continued use will reduce friction and make increased speed possible. We ask all purchasers of insignia to be patient during these beginning months of our new business, and express our assurance that the service will improve as we gain in experience. We are certain that we are producing insignia of better quality than any that have been hitherto procurable from any jeweller and that our prices are more favorable than those previously in vogue. We fully expect eventually to be able to fill all orders within three days of their receipt.

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This issue contains accounts of important Sigma Xi alumni gatherings, which are sure to be of interest to all. During the last three months the secretary's office has been busy circularizing all alumni whose addresses are on our files, offering opportunity to contribute to the alumni research fund, to subscribe for the official journal and thus to resume and maintain contact with the society and its purpose. To date, approximately one thousand have responded, and in the September issue we will report the awards of fellowship made by the fellowship committee, which consists of Dr. W. R. Whitney, Director of Research, The General Electric Company; Professor E. L. Thorndike, Columbia University; Dr. John H. Northrup, Rockefeller Institute of Medical Research.

At that time we will also publish brief reports from the Sigma Xi Fellows of 1926–27.

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The attention of chapter members and alumni is respectfully called to the minutes of the Spring Meeting of the Executive Committee. It was an all-day session, from nine o'clock in the morning to five in the afternoon. At the close of the meeting, the members of the committee were invited to the home of President and Mrs. Richmond of Union College for tea, and visited the office of the national secretary to survey the progress of the work of organizing and systematizing the society's records. A complimentary dinner was given the committee by the Rensselaer and Union chapters and alumni of this section.

* * * * * *

The "Model for Chapter Officers," published in the December issue of the QUARTERLY, has elicited comments from chapter officers, and among them a request that the secretary's reply to Dr. Livingstone be published. The national officers are gratified at this evidence that the official journal of the society is read by those who receive it and that chapters are interested to further the progress of the society in their respective institutions.

The verbatim reply of the secretary it is not necessary to print. The items will suffice. Here they are:

1. HISTORY: A well-written history of the society from the pen of Professor Henry B. Ward is given in the Quarter Century Record of Sigma Xi, published in 1911. It tells the story of the foundation and development of the organization, and clearly sets forth its spirit and purpose, and the steps by which it advanced to its position of honor and influence. A few copies of the Record are still available in the secretary's office at $2.50.

The history of the last decade, showing how the society became an international organization, originated two classes of members (associates and members) and offered fellowships, is being written at this time, and it is hoped that within the current calendar year, the whole will be published in pamphlet form so that each member of Sigma Xi who wishes it may have a copy.

2. ELECTION TO MEMBERSHIP: The policies of Sigma Xi and of Phi Beta Kappa, with which our society has often been compared, have differed much. Sigma Xi elects to membership, not only on

the basis of standing attained in prescribed courses of study, but also upon the basis of ability in research. If an undergraduate gives promise of that ability in his undergraduate days, he is elected as an associate, with privilege of wearing the Sigma Xi pin. When and if an associate completes a piece of research work worthy of publication he may be promoted to membership, with the privilege of wearing the Sigma Xi key. Graduate students, faculty members, and others who have made noteworthy achievement in scientific investigations are eligible as members.

3. FINANCIAL MANAGEMENT: The treasurer's report is annually printed in the March issue of the QUARTERLY.

4. SIZE OF THE SOCIETY: The number of enrolled members (i. e., members connected with chapters) is over 5000. The number of alumni members is over 15,000.

5. THE FELLOWSHIPS: During last year the fund amounted to about $6000 contributed by 1500 alumni. Public notice is given each Spring that fellowships are available. Awards are made by a fellowship committee, consisting of Dr. W. R. Whitney, Professor E. L. Thorndike and Dr. John H. Northrup. The list of awards is published in the June issue of the QUARTERLY.

6. CHAPTER MEETINGS: Many of the chapters make all their meetings public meetings. This is good policy. It keeps the society before the public, and also gives an opportunity to the public to become acquainted with those scientific subjects which chapters present in the papers read. The society is not secret in any sense, and chapter business may be transacted at the time of a public meeting, if the chapter does not wish to designate some special meeting for the purpose, open only to members.

THE STATE AND SCIENTIFIC RESEARCH

GOVERNOR ALFRED E. SMITH

[A Telegraphed Letter Received and Read at the Dinner Given t
Executive Committee in Schenectady, April 29]

Albany, N. Y., April 29, 192
6:01 P.M.

Dean Edward Ellery

Dear Dean Ellery: I am sorry that official duties prevent m being with you this evening but I am glad to send a brief messag This is an age of research in all the varied activities of life. Gre corporations are employing men for research work that will sol the problems of finance, of production in industry, of salesma ship, of economy and waste. The devotion of men giving the lives to research work in solving the problems of disease and t conservation of health has brought about great medical discoveri that have revolutionized methods and procedure in the conserv tion of health. Research in the field of electricity, of methods travel and intercommunication have brought to this generati discoveries that seem almost miraculous in their results. T radio and aerial navigation have brought about conditions that generation ago would have been laughed to scorn.

While all these things are true and the results have been co ducive to the general progress, the work has been done by ind viduals and by societies at private expense. The enormo mineral wealth of the state is unknown. The great possibiliti resulting from right development of the water power of the stat the solution of her forestry problem, the reclamation of her was lands, these and other questions for solution are depending abs lutely upon scientific painstaking research and the day is at han I believe when the state must recognize her duty and obligati to lend support to such scientific research.

ALFRED E. SMITH,
Governor

6:50 P.M

ANNUAL NEW YORK DINNER OF SIGMA XI ALUMNI

DR. ALEXANDERSON DEMONSTRATES TELEVISION

Television, as explained and demonstrated by Dr. E. F. W. Alexanderson, was the center of interest at the third annual New York dinner of Sigma Xi, held in the Hotel Astor on April 18. The speaker, who is consulting engineer for the General Electric Company and chief consulting engineer of the Radio Corporation of America, talked to a group of 150 representative alumni, whose natural interest in matters of this sort had been intensified by recent announcements of sensational developments in television.

The New York dinners of Sigma Xi alumni residing in the metropolitan district were inaugurated two years ago by a dinner held at the Fraternities Clubhouse where a group of 150 outstanding scientists representing such diverse fields as psychology and cancer research, electrical communication and chemistry, drew a composite picture of the "new battle front of civilization"—scientific research. It was the brilliant consummation of an effort, to bind together informally and pleasantly the many Sigma Xi men and women who make New York the scene of their activities.

There was no formal organization of the alumni. It was felt that this might be looked upon as an unnecessary burden. What was desired and attained was merely an inspiring contact of men and women having a common interest in scientific research.

The second annual dinner was held last year at the Columbia University faculty club. The dissemination of scientific knowledge through the press and otherwise was the main theme of the addresses, which were followed by a most interesting demonstration of the piezoelectric effect by Columbia physicists. "Crystals Squeal and Atoms Flop at Sigma Xi Dinner" headlined one newspaper report the next morning.

With interest fully sustained at the third dinner, here reported, it seems that the custom of annual New York Sigma Xi dinners has passed the test of alumni approval and is established on a permanent basis.

The toastmaster this year was a prominent New York alumnus, Edward J. Mehren, vice-president of the McGraw-Hill Publishing Company. Introducing the speaker, he referred humorously to the

possibility of extending the other senses—particularly the sense of touch and smell—as hearing and sight have now been extended.

Dr. Alexanderson's address follows:

"It seems to be written in the stars that the next step in radio is going to be to see as well as hear by radio. It seems that when the scientific basis for a new achievement exists the practical development will follow with inevitable necessity. The scientists, inventors and engineers who became interested in these technicalities are only the tools of destiny.

"One of the important scientific discoveries now being brought into the picture is the relation between the light ray and the electron. When the light ray strikes certain substances under some conditions it bounces off an electron which flies into space. If suitable arrangements are made it can be caught again and transformed into an electrical current in a wire. This current in its turn will trigger off certain other electron devices and new electric energy will be released as radiating wave energy. Then somewhere this radio wave will be absorbed by an antenna and trigger off some new electrons. They, in turn, will trigger a ray of light which will be a reproduction of the original ray of light that started this whole process. To do all this properly will, of course, require attention to a great many details but the scientific principles are all there.

"The electric power industry cannot much longer remain untouched by these discoveries. It is just waiting until this new knowledge has been widened and matured so that it can be put to use on a large scale. This is the real significance of the excursion of the electric industry into radio and the latest branch of it—television.

"Many have thought that the electric power industry is a finished chapter from the scientific point of view, but now a whole new set of discoveries bursts upon us and makes us feel that we are only just beginning to know something about electricity. This march of progress is necessarily slow; it is an evolution and not a revolution.

"Television is a subject that has been in the minds of inventors and imaginative writers for a long time. During the early days of telephony there was much discussion of the possibility of an attachment to the telephone by which one could see the person with whom he was talking. Radio has revived interest in the subject. Now that transatlantic telephony is offered as a public service, everyone is asking whether there is a reasonable prospect that we will be able to see as well as hear at a distance.

"There are a number of problems that are common to photo-telegraphy and television; as far as they can be disposed of by actual experience in radio photography it becomes that much easier to narrow down our analysis to the crucial problems of television.

"One of the problems common to radio photography and television is the method of translating the picture into radio waves. We have developed four such methods, each of which has its own particular usefulness.

"The first, which may be called the broadcast method, is illustrated by the pictures I have shown. If you listen to the transmission of such a picture with an ordinary broadcast receiver you will simply hear a shrill note of about 3000 cycles. When the sound is strong it means that we are passing over a white portion of the picture; when the sound is weak, we are passing over a gray portion of the picture, and when the sound is absent, over a black portion.

"The second method may be called the continuous-wave process. Every radio listener is familiar with what happens when he or his neighbor makes his receiver oscillate. A shrill note is produced which may be heard regardless of whether any speech or music is being transmitted at the moment. As a matter of fact distant stations may thus be detected when this shrill note is altogether too weak for reception of music or speech. When the sound is of full intensity the record will be white, of half intensity, gray, and when the shrill note is absent it will be black. Using this method of detection, pictures can be transmitted over a much greater distance than with the broadcast method.

"The third method may be called a telegraphic or interruption process. In this case the receiver is adjusted so that it does not differentiate between signals of low intensity and of high intensity. If the signal can be heard at all, it records black. Otherwise it records white. This method of transmission adapts itself for facsimile or typewritten sheets, printing and handwriting.

"Records of this method have been made at speeds of 200 words per minute, which is faster than one ordinarily reads.

"The advantage of the photographic method of recording is that the results are independent of 'fading.' Wherever a telegraphic code message can be recorded by present-day methods we will have a legible facsimile record of writing.

"The fourth method was devised to reproduce half-tone pictures, with a method of recording that has the same independence of fading

as the telegraphic method. Each point of the sensitized paper in the recording machine is exposed to the ray of light four times in succession. The light is adjusted so that one exposure will give the shade of light gray; four successive exposures will give black. Thus, we have a five-shade process giving white, light gray, medium gray, dark gray and black. This process will probably become popular among amateurs who are now communicating regularly with their friends in South Africa and New Zealand. It will enable one to get a half-tone picture in five shades wherever he is now able to receive a code message.

"The principal difference between radio photography and television is this: In radio photography we can take our time, whereas in television we must produce a picture in one sixteenth of a second so that the pictures may succeed each other on the screen as they do with a moving-picture projector.

"One of the greatest difficulties in designing a television projector was to find a way to cover the screen with a sufficient volume of light. The photographic pictures are made by passing a spot of light over the sensitive paper point after point until the whole picture is covered. A picture such as I have shown requires at least 300,000 separate light impressions per second, and there does not seem to be any way to get a light spot so brilliant that if it stays in one place only 1/300,000 of a second it will register a sufficiently strong impression in our eye. We have therefore arrived at the conclusion that we have to use seven beams of light simultaneously. With this arrangement each beam can be made seven times as bright so that we get forty-nine times as much illumination.

"Now the whole world is working on this problem. We hear a good deal about developments in England and Germany. Recently the Telephone Company gave a demonstration in which Secretary Hoover, speaking in Washington, was seen and heard in New York. This demonstration was an important contribution to the new art, proving that television signals can be carried long distances over wire lines. Without wire connection television might become an interesting experiment, but would not be of value to the general public. A radio television system for either communication or pleasure will always require a wire line, such as is now common practice with broadcasting stations, between the scene of action and the radio station. All the work that has been done in developing systems for pick-up and reproducing television images has been done with the

expectation and hope that the telephone engineers would find a solution of this problem. The fact that this demonstration has been given to the world at this early date is a great encouragement to all those who are interested in and working on television systems."

Dr. Alexanderson's address was accompanied by exhibits of portraits sent by wire, by motion pictures of the operation of the television apparatus developed at the General Electric laboratories and by a demonstration of the rotating prisms which paint the subject and the receiving screen with rapidly moving spots of light.

In the course of the evening Chairman C. E. Davies of the dinner committee spoke of the encouraging support given to the Sigma Xi research fund by the alumni. By contributing to this fund, each alumnus participates in research, because the major part of the proceeds is devoted to the encouragement of research by grants of various kinds to workers in science.

MEETING OF SIGMA XI ALUMNI OF NEW YORK STATE CAPITAL DISTRICT

Sigma Xi alumni resident in the Albany-Troy-Schenectady section of New York state, together with members and associates of the Rensselaer and Union Chapters gave a complimentary dinner to the Executive Committee of the Society at the Hotel Van Curler in Schenectady, April 29. There were about two hundred present to welcome the guests and to hear the addresses. The guests were

Professor F. R. Moulton.....President
University of Chicago

Dean Edward Ellery.....Secretary
Union College

Dean George B. Pegram.....Treasurer
Columbia University

Dr. Vernon Kellogg.....National Research Council

Professor Henry B. Ward.....University of Illinois

Dr. William F. Durand.....Leland Stanford University

Dr. Willis R. Whitney.....Director of Research
General Electric Company

Professor George A. Baitsell.....Yale University

Mr. Clarence E. Davies.....Alumni Representative
New York City

Professor F. K. Richtmyer.....Cornell University

Dr. Hugh P. Baker.....Member of Alumni Committee
New York City

At the dinner, Professor Peter Irving Wold, president of the Union chapter, and Professor L. W. Clark, president of the Rensselaer chapter, presided. Thirteen associates and one member, elected by the Union chapter were inducted into the society by Professor Moulton, national president. Greetings were extended by Governor Smith (letter printed on page 30), by Mayor Alexander T. Blessing of Schenectady, by President Ricketts of Rensselaer, President Richmond of Union, and by Mr. Gerard Swope, president of the General Electric Company, by letter to Dean Ellery.

The following addresses were given:

Sigma Xi in Education:

Dr. Frank Pierrepont Graves, Commissioner of Education for the State of New York (page 39).

Sigma Xi in Research:

1. "Coagulation Phenomena in Relation to Tissue Formation," Professor George A. Baitsell, Yale University.
2. "The Meaning of 'Wave Length' in Theories of Radiation," Professor F. K. Richtmyer, Cornell University (page 42).
3. "Animal Parasites and Human Welfare," Professor Henry B. Ward, University of Illinois.

Professor Ward spoke in part as follows:

"While some of the unbidden guests which man shelters were recorded in the earliest known medical writings, the demonstration of the majority and the elucidation of the complex life cycles of the more minute and more dangerous human parasites are products of the research of the twentieth century. Although investigation has eliminated the fantastic ideas of the origin of parasites held by primitive man and developed during the imaginative ages, it has disclosed even more intricate and wonderful interrelations between parasite and host. The myriad adjustments involved are of the most precise sort.

"The elaboration of these close harmonies in the stories of malaria, of the hookworm and of yellow fever, *inter alia*, have given a scientific basis for an understanding of the origin and spread of these and many other serious diseases. The study of the delicately attuned relations has also indicated points at which the parasite and hence the disease may be successfully attacked. Out of such studies has come the power with which man is now for the first time in all human history pressing successfully the conquest of the tropics. On the solution of the problems presented by animal parasites depend the material prosperity, the health and happiness, and even in some degree the existence of the human race."

Professor Baitsell spoke in part as follows:

"Blood coagulation is one of the most interesting things that I have studied. In the case of broken skin and the subsequent flow of blood, the wounded cells in the blood give off a substance that in the presence of the calcium in the blood unites with another con-

stituent in the blood and forms a crystalline substance that precipitates from the blood. This precipitate forms a scaffolding around the break in the skin, and effectually stops the flow of blood. This blood clot is then formed into a substance very similar to the interfibrous structure of cells by the processes of nature."

SIGMA XI IN EDUCATION

FRANK PIERREPONT GRAVES

Commissioner of Education for the State of New York

(Address at Sigma Xi Dinner to National Officers, Hotel Van Curler, Schenectady, April 29, 1927)

MR. PRESIDENT AND MEMBERS OF SIGMA XI:

The selection by your executive committee of one who has spent a lifetime in blissful ignorance of scientific research to extend a welcome to the most distinguished group of scientists in America, would at first seem to be a delicious bit of irony. It is like placing a court jester upon the judge's bench to pass upon a mooted question in philosophy, or asking the late lamented Nebraskan to expound the theory of organic evolution, or requesting the views of a certain nameless city official upon American history texts. Yet this procedure is quite in harmony with our American reputation for versatility, sciolism and unlimited assurance. Any American, it is believed, can do anything, provided he is for the time being clothed with a little "brief authority" and confirmed in the apostolic succession by the laying on of hands. President Coolidge welcomes the Amalgamated Order of Barbers or a delegation of vaudeville monologists, while Mayor Hylan offers the keys of the metropolis to the Royal Family of Belgium or to the International Association of Comparative Philologians, all with equal grace and facility. Why, then, should you not invite a time-worn schoolmaster, having a temporary abode in the offices of the Commissioner of Education, to extend the greetings of New York to that international organization of science workers which not only had its origin in a university of this state but likewise organized its second and third chapters in colleges of this Capital District? It may be urged in further extenuation of your action that this particular schoolman happens to be one of the trustees at the institution where your great organization of scientists arose and is on his way to participate in their quarterly deliberations tomorrow, and is likewise a close friend and honorary alumnus of the other two colleges and is even now standing within their environs.

Again, it is not merely by virtue of official position that I may

claim the right to bid you welcome, but rather because of the fact—if I may judge from my experiences with four other honorary Greek letter societies—that I am probably one of those esoteric few who have learned the Greek title which the initial letters of your society represent and that I can tell which of the two words signifies "companions" and which "in zealous research." This extraordinary erudition of mine is due, in part, to my having in my youth been guilty of teaching the language of Homer and Demosthenes, and, in part, to the fact that I took the precaution to look the matter up just before I came here this evening.

The Hellenic appellation of the Society is undoubtedly dignified and impressive, and, in a measure, is singularly appropriate, for the Greeks were in very truth the first great scientists. It may well remind us that we must ever hark back for the beginnings of research to Pythagoras and Democritus, Aristotle and Chrysippus, Hippocrates and Galen. But, as a matter of fact, the title of the organization, like its constitution, key, grip, meetings and other externals is comparatively inconsequential. It is, after all, merely a symbol and a means of identification for the public. It might as well have been The Elks, The Owls or The Odd Fellows. The real society exists in its spirit and not in its name. The actual tie that has all these years bound the members of Sigma Xi together is invisible. It is woven out of the ideal of the Society—the pervasive, all-conquering and creative spirit of investigation and research. This force it is which has preserved the vitality and virility of Sigma Xi and has ever renewed its youth like the eagle's through the constant infiltration of new and vigorous blood. It has ever been the most important mission of this organization, in scanning the students of colleges and universities of this country, to descry that peculiar genius and ability in research which is never to be learned from books and can never be recorded in scholastic rank, but which marks the embryo scientist and silently urges him on more potently than any degree or prize. And once discovered, because of this spirit, the youthful genius becomes a recruit to the ranks and is welcomed as a "companion in zealous research." He is constantly stimulated by example, and is ungrudgingly offered all possible material and spiritual aid in his aspirations by those who have been traveling the same road a little longer.

But it was not always thus. As in all other intellectual tendencies, the colleges and universities have been notoriously slow in their recognition of the development of natural science and the promotion

of research. Monopolies and vested interests have constantly hampered the progress of American education. The modern movement in science began in the seventeenth century, but almost at the close of the nineteenth the great majority of higher institutions were dominated by the Classics. Greek and Latin were in my day, for example, required through the Junior Year at Columbia, and our opportunities for instruction in Science were less generous than those now afforded by a first-class high school. Some of us must, in consequence, until the end of our days remain ignorant of the first principles of the physical world about us, and will never be able to acquire the imagery and terminology of evolution, which today permeates every field of knowledge.

Yet the nineteenth was the century in which, working outside the universities, Hutton developed the Plutonic theory of continents and Agassiz traced the effects of the universal ice age. During this epoch Darwin explained the origin of species and Mendel expounded his principles of heredity, while Newlands formulated the periodic law of chemical elements, and Joule and Mayer discovered the conservation of energy. More than a century before my day in college, too, in this very country, through Franklin and Jefferson, had been organized from membership quite outside the universities several scientific associations, including the famous American Philosophical Society, which is this very week-end engaged in celebrating its bicentennial in Philadelphia.

How happy and unusual, then, was that movement of students and professors, led by Henry S. Williams, which some forty years ago marked the awakening of science in American institutions of higher learning, and brought about the foundation of the first chapters of Sigma Xi at Cornell, Rensselaer and Union. Within little more than a generation this little band of "associates in zealous research" has spread its members from ocean to ocean, and now embraces within its membership all outstanding scientists—some twenty thousand all told—in nearly half a hundred organized chapters in the United States and Canada. It assuredly affords me unlimited pride and gratification that this homecoming to the Society's natal state should have occurred during my incumbency of the Commissioner's office and that I should be privileged to bid the National Officers welcome in the name of the schools of New York and of the Mother Chapter and the Second and Third Born of that fertile and happy family of scientific groups, which has put forth such determined efforts and wrought such advances in behalf of human welfare.

THE ROLE OF WAVE LENGTH IN MODERN THEORIES OF RADIATION

By F. K. Richtmyer

Professor of Physics at Cornell University and Past President of Sigma Xi

(Text of an address delivered at the annual dinner of the Union Chapter of Sigma Xi, April 29, 1927.)

Mr. Toastmaster, Members of the Union Chapter of Sigma Xi and Their Guests:

For two and a half centuries physicists have been trying to answer the question: "What is radiant energy?" Or in somewhat less technical language, "What is that 'something' which, starting from the sun and rushing through space at the rate of 186,000 miles per second, brings light and heat and cheer and life to the earth; what is it which, leaving the filaments of incandescent lamps in this room, proceeds to our eyes after reflection from the various objects near us and causes the sensation of vision?" Answers to this question have been given by various scientists and groups of scientists. Sometimes one answer has been given; sometimes another, and I have chosen to discuss this subject upon this occasion because more than any other subject perhaps in the whole history of science, it illustrates the importance of these fundamental principles for which Sigma Xi, the Society which brings us together this evening, stands, namely the search for truth and the reception of truth whenever found with an open mind and with a readiness, when incontrovertible experimental evidence becomes available, to discard theories, however long established, which are in conflict therewith.

The discussions concerning the nature of light assumed definite form about two and a half centuries ago when two great scientists whose names are now almost household words in physics, gave different answers to the questions above raised, each on the basis of his own best judgment of the experimental data then available. These two great men were Huyghens, the Dutch physicist, who lived during the seventeenth century and his younger contemporary Newton, that great English scientist and philosopher, the 200th anniversary of whose death has just been observed throughout the scientific world.

Huyghens, knowing the tremendous speed with which light travels, thinking it impossible that material bodies, for example, could travel at that rate, concluded that light must be a wave motion in a substance called the ether which, according to his hypothesis, filled all space between the sun, the planets and the stars, and even permeated the "pores" of transparent bodies, such as glass and water. Huyghens pictured this wave motion in the ether as analogous in every way to the wave motion of sound through the air, except that the velocity of light is many hundred thousand times greater than the velocity of sound. Thus was born the so-called undulatory or wave theory of light.

Newton, on the contrary, although realizing the importance of these arguments put forward by Huyghens, gave greater weight to the experimental fact that light travels in straight lines, whereas sound, it is well known, "bends around corners." Thus, if an opaque object be interposed between a light source and an opposite wall, a sharp shadow of that object appears on the wall; whereas if a solid obstacle intervenes between the source of my voice and your ears, you have no difficulty in hearing the sound. Accordingly, Newton suggested that, since light travels in straight lines unless it is reflected or refracted by some material body and since projectiles or moving bodies, such as rain drops, likewise travel in straight lines unless deflected by impact with some other object, the arguments are very strong in favor of light being a motion of very minute corpuscles or small bodies in somewhat the same way as a rain shower is a motion of small droplets of water. Light, according to Newton, consists of swiftly moving particles; and thus was born the so-called corpuscular theory of light.

During the life times of Huyghens and of Newton, some scientists agreed with one theory, some with the other. But for nearly a century after Newton's death, there was no further addition of experimental evidence on the basis of which to reach a decision as to which of the two theories was correct. Perhaps because of the greater prestige of Newton, perhaps because greater weight was given to the experimental fact that light travels in straight lines, the wave theory almost entirely disappeared during the first half of the eighteenth century and from 1750 to 1800 nearly every scientist supported the corpuscular theory.

In 1802, however, occurred a very momentous event in the history of science. In that year Thomas Young, the English scientist,

discovered a new experimental fact, namely, the now well-know phenomenon of interference of two beams of light. He demonstrate that it was possible for two beams of light, starting from the sam source and traveling by slightly different paths, to fall at the sam point on a surface and produce on that surface not light but darkne that is to say, one beam of light exactly neutralized or cancelled t effect of another. Accordingly, Young assumed, and no one sin that time has succeeded in proving that the argument is untenabl that this phenomenon of interference could be explained only if lig be a wave motion.

Let me illustrate: If you drop a series of stones, one after anothe into a pond of water, you send out waves. A chip floating on t surface of the water will bob up and down as the train of wav passes. You can quite readily imagine another series of water wav related to the first in such a way that the second at any given insta will tend to make the chip go down while the first would tend to ma the chip go up. The chip accordingly might be made to stand sti although two sources of waves are passing over it. These t wave trains would then be said to "interfere." On the contra it is so impossible as to be quite ridiculous to imagine two streams rain drops striking a surface from slightly different directions a producing dryness rather than wetness. The corpuscular theory light could not, and cannot now, explain this phenomenon of inte ference.

During the next four or five decades, Young's experiments we confirmed on every hand and every newly discovered experiment fact seemed to confirm the wave theory, so that by the middle of t nineteenth century, there were few, if any, scientists who believe in the corpuscular theory. At last, on the basis of good sound i controvertible experiment, the wave theory had triumphed.

Meantime, in various ways experimenters have measured wa lengths of light. If you have stood on the shore and watched t breakers roll in, I am sure that you have had no difficulty in appr ciating the meaning of wave length. And it is a simple proper of wave motion that the velocity with which the wave train moves equal to the product of the wave length multiplied by the frequen of vibration. Since the velocity of light was known, and since i wave length for the various spectral colors could be measured, t frequency corresponding to these various colors could be compute

From 1850 until the present, our knowledge of these ether wave

as some of us are old fashioned enough to call them, or more correctly, electromagnetic waves, as the wonderful theory of James Clark Maxwell proved them to be, has become very extensive. We have become very familiar with electromagnetic waves of all kinds in connection with both pure and applied science, so that we are now acquainted with a vast gamut or spectrum of waves extending from radio waves many miles in length, such as are in use today in trans-Atlantic radio telephony to the short waves emitted by radio-active substances, so short that it takes billions of them to make an inch, which are used in curing cancer and similar maladies. Between these two extremes, we have the short electromagnetic waves, a few hundredths of an inch long; the so-called heat waves, a few thousandths of an inch long; light waves, a few ten-thousandths of an inch long; ultra-violet rays a few hundred thousandths of an inch long and x-rays a thousand times shorter than these. Nothing in the whole realm of physics, either pure or applied, seems more real than these electromagnetic waves.

But let us go back exactly four decades in the history of physics to a time when Sigma Xi was one year old, namely, to 1887. In that year occurred another momentous event in the history of radiation. The German physicist, Heinrich Herz, in that year discovered a new experimental fact, which was destined to play the same role in connection with the corpuscular theory of light as was the phenomenon of interference, discovered by Young, in connection with the wave theory of light. This discovery made by Herz is called the "photo-electric effect." Time does not permit an explanation of this phenomenon. Suffice it to say, however, that later experiments following those of Herz, have shown that when light falls upon a metal surface under certain easily specified conditions, electrons are liberated from the metal by the action of light. Any one who has used the radio is, or should be, more or less familiar with the electrons which leave the heated filament in the vacuum tube and make possible modern radio transmission and reception. By modern experimental methods we can measure very easily the number of such electrons which are emitted from a square inch of a metal when light of a measurable wave length and intensity falls upon the metal. We can also measure the velocity with which the electrons are caused to leave the metal and can, therefore, determine the energy which each one carries. We also have good evidence for believing that the electrons come from the atoms of the metal and we can readily determine the number of

atoms in a square inch of surface of the metal. Knowing the ener received each second by each square inch of the metal and on the bas of the wave theory of light, assuming that each one of this va number of atoms absorbs only its own proportionate quota from t radiant energy, we can compute how long it ought to take for an ato to absorb enough energy to expel an electron, even though we ha no knowledge of the atomic mechanism involved. When we make computation of this kind on the basis of indisputable experiment data, we find it ought to take several hours or even days before a atom can get enough energy from light to expel an electron. Th should mean that it would be a long time after light falls upo a metal before electrons would be emitted from it. But as a matt of fact, so-called photoelectro emission begins instantly. Indee according to some measurements reported a few days ago in Was ington at the meeting of the American Physical Society, the time la if any, between the beginning of photoelectric emission and illumin tion is certainly not more than a few billionths of a second.

It is practically impossible on the basis of the wave theory to e plain the photoelectric effect and many similar phenomena whi have been discovered in recent years and which are now grouped und the general name of "quantum phenomena." If, however, we we to assume with Newton that light was corpuscular in its nature, would be perfectly possible for us to explain many facts of the phot electric effect and others related thereto. Indeed, in recent yea these "corpuscles of radiant energy" have come to be almost as re in this branch of physics as have waves in connection with the wa theory of light. For example, we know the amount of energy carri by each corpuscle. This energy varies with the frequency of th light or radiation and is equal to a certain constant of nature, know as Planck's constant, multiplied by the frequency of light. Th amount of energy is frequently spoken of as a "quantum" of radiatio

The situation, then, with regard to the theories of light is brief this: On one side of an almost impenetrable fence is to be found group of experimental facts, according to which we should say, witho the slightest hesitation, that light is a wave motion. On the oth side of the fence is another group of experimental facts, according which we should say, without the slightest hesitation, that light corpuscular if we did not know what was on the first side of th fence. So far as reaching a categorical answer to the question, w are no nearer than were Huyghens and Newton. But there is th

very fundamental difference between the present situation and that which existed two hundred and fifty years ago, namely, we have in our possession a vast amount of experimental data on the basis of which a decision may be reached.

There is further a curious cross relation between these two theories, which was not known to Huyghens and to Newton. I have stated that the energy of a light quantum is equal to the product of a certain constant and the *frequency* of the light. Now, it is a question which has never been satisfactorily answered as to what can possibly be the meaning of frequency in connection with a corpuscular theory of light. The frequency with which water waves pass the chip is a perfectly concrete thing. But what can possibly be the meaning of frequency as applied to a falling rain drop? Nevertheless, a quantum of radiant energy somehow is intimately connected with frequency, but in our experimental laboratories we do not measure the frequency of light waves directly. Indeed, we have no way of making such measurements. What we measure is wave length and velocity of light on the assumption that light is a wave motion and from these measurements we then *compute* frequency. This computed value of frequency, obtained on the theory that light is a wave motion, we then carry blindfolded over the fence and use in computing the energy of the quantum. It is possible that out of this cross-connection between these two rival theories of light may come a possible means of harmonizing the two theories or of developing some entirely new theory to account for both groups of phenomena.

At any rate, scientists have learned a very important lesson by the experience of the past two and a half centuries. We have learned, for example, that it is not safe dogmatically to assert that any particular theory is finally correct and will, therefore, stand the test of time. We have learned to look for and to respect new experimental evidence and to revise our theories whenever they are found in conflict with experiment. It is this search for truth in all branches of science and the sincere interpretation of experimental data without bias, which has in large part made possible the tremendous advance in science, which advances have been contemporaneous with and perhaps not a little influenced by the Society of Sigma Xi.

MINUTES OF THE EXECUTIVE COMMITTEE MEETING OF SIGMA XI

Schenectady, N. Y., April 29, 1927

The spring meeting of the Executive Committee was held in t Mohawk Club, Schenectady, New York, Friday, April 29, 192 The meeting was called to order at 9:00 A.M. by President Moult Those present were: President Moulton, Secretary Ellery, Treasur Pegram, Professor Ward, Dr. Whitney, Professor Richtmyer, Pr fessor Baitsell, Mr. Davies, and by special invitation, Dr. Hugh Baker, newly-elected member of the Alumni Committee. D Kellogg was unable to attend the conference because of importa committee meetings of the National Research Council in Washin ton, and Dr. Durand was compelled to represent the State of Ca fornia at a conference in Yuma, Arizona, called by the Secretary the Interior for the United States to consider certain Colorado Riv projects.

Business was transacted as follows:

1. UNIVERSITY OF MARYLAND:

Consideration of the printed petition presented by a group at t University of Maryland at the December meeting of the committe and postponed to the spring meeting resulted in the following vot

Voted—To recommend to the 1927 convention favorable acti upon the printed petition from a group of workers at the Universi of Maryland. The resolution was carried without dissenting voic

2. KANSAS STATE AGRICULTURAL COLLEGE:

An informal petition from Kansas State Agricultural Colleg giving information in detail about the equipment of the institutio endowments, income, facilities for research and output of researc was given careful consideration.

Voted—That President Moulton should appoint an official visito to confer with the administration and the group of petitioners at th Kansas State Agricultural College and that the visitor should repo at the December meeting of the committee.

3. CLARK UNIVERSITY:

Voted—That the group of possible petitioners be requested to pr sent an informal petition for the consideration of the committee at it December meeting.

4. PENNSYLVANIA STATE COLLEGE:

Voted—That the group of possible petitioners be requested to present an informal petition for the consideration of the committee at its December meeting.

5. STATE COLLEGE OF WASHINGTON:

Voted—That the group of possible petitioners be requested to present an informal petition for the consideration of the committee at its December meeting.

6. LEHIGH UNIVERSITY:

Dean Pegram, who was appointed official visitor to Lehigh University at the October meeting of the committee, made a report of his conference with the administration and members of the faculty and of his survey of the equipment of the institution.

Voted—That the group at Lehigh University be encouraged to present a printed petition at the December meeting.

7. UNIVERSITY OF ILLINOIS COLLEGE OF MEDICINE:

A request from sixteen members of the faculty (persons who are already members of Sigma Xi) of the University of Illinois College of Medicine for the establishment at that institution of a chapter separate from the chapter at the University of Illinois in Urbana was considered at the December meeting and again brought up at this meeting. Detailed information about the College of Medicine—its equipment, endowments, opportunities for research and output of research—was presented. The action of the University of Illinois chapter, agreeing to the establishment of a separate chapter at the College of Medicine, was presented by Secretary Ellery. After full consideration, the following vote was taken:

Voted—That the group of petitioners at the University of Illinois College of Medicine be invited to present a printed petition at the December meeting.

8. REPORT OF THE SECRETARY ON CIRCULARIZATION OF ALUMNI:

The Secretary reported that at the date of the meeting, 10,000 letters had been sent to alumni associates and members inviting contributions to the Alumni Fund and that the total of subscriptions at the time amounted to $1386.00.

9. REPORT OF THE PRESIDENT ON ACTIVITIES OF CHICAGO ALUMNI:

The President reported a movement among a group of Sigma Xi alumni, associates and members, in Chicago looking toward a per-

manent grouping for the purpose of keeping before the general publ in that section the objects of Sigma Xi. The proposed activiti would consist largely in presenting to the public each year three four lecturers of note on topics which represent considerable researc and investigation. The executive committee expressed its approv of the proposal and pledged its coöperation.

10. AMES CHAPTER:

A request from the Ames chapter for change of name to the "Iow State College" chapter was received. A communication was rea from the Iowa chapter in which it was stated that that chapter ha no objection to the change. It was

Voted—That a recommendation be made to the 1927 conventio that the name of the Ames chapter be changed to the "Iowa Stat College" Chapter.

11. REPORT OF THE TREASURER REGARDING THE BUDGET:

Dean Pegram reported for the sub-committee on budget (Pegra and Moulton) the budget for 1927 as follows:

Budget

Quarterly	$1200.00
Secretary's Office	4200.00
Officers' Travel Expense	600.00
Engrossing Charters	120.00
TOTAL	$6120.00

$400.00 of this budget to be charged against the alumni funds.

Voted—That the budget be approved as proposed.

12. LIFE MEMBERSHIP:

Mr. Davies reported for the sub-committee on life-membership (Davies and Pegram) that the committee had given considerable attention to the matter, that progress had been made and asked for an extension of time in which to make a more complete report.

Voted—That this sub-committee on life-membership be requested to continue its consideration of the subject and to make report at some future meeting.

13. INVESTMENTS:

Voted—That the Treasurer be given authority to invest from the cash on hand such sums as he sees fit.

14. VISITS OF OFFICERS TO CHAPTERS:

Voted—That the Secretary take the initiative in arranging for visits to various chapters on the part of the national officers.

15. HISTORY OF THE SOCIETY:

The Secretary called attention to the fact that there had been no history of the Society written since 1911 and expressed the opinion that it would be well if someone could compile the history of the Society since that year. It was

Voted—That Professor Ward be asked to prepare a history of the Society since 1911 at his convenience.

16. THE NASHVILLE CONVENTION:

The sub-committee on convention (Richtmyer and Ellery) asked the committee for suggestions regarding a speaker for the joint meeting of the Society with the American Association for the Advancement of Science to be held in Nashville, December 27, 1927. Many suggestions were made and the sub-committee was continued and given power to act.

EDWARD ELLERY, *Secretary*.

CHAPTER OFFICERS

LIST FURNISHED BY THE CORRESPONDING SECRETARIES OF THE CHAPTER

CHAPTER	PRESIDENT	VICE-PRES.	SECRETARY	TREASURER
Cornell	R. C. Gibbs	O. A. Johannson	W. A. Hagan	A. J. Eames
Rensselaer	L. W. Clark	G. K. Palsgrove	E. M. Clark	W. J. Williams
Union	P. I. Wold	J. W. Mavor	C. B. Hurd	C. B. Hurd
Kansas	O. O. Stoland	R. C. Moore	G. W. Smith	H. E. Jordan
Yale	P. G. Laurson	Blair Saxton	A. F. Hill	L. E. Seeley
Minnesota	C. H. Bailey	M. C. Sneed	J. H. Van Vleck	Wm. Cooper
Nebraska	H. H. Marvin	E. F. Schramm	P. B. Sears	M. G. Gaba
Ohio	C. H. Kennedy	J. H. Weaver	J. E. Day	S. E. Rasor
Pennsylvania	T. D. Cope	R. H. True	W. H. Barton, Jr.	W. R. Taylor
Brown	S. T. Arnold	J. W. Wilson	Bradford Willard	C. R. Adams
Iowa	C. A. Ruckmick	C. J. Lapp	N. O. Taylor	F. A. Stromste
Stanford	Leroy Abrams	W. R. Eckart	E. W. Schultz	E. W. Schultz
California	R. T. Birge	Agnes F. Morgan	T. D. Beckwith	C. D. Shane
Columbia	D. W. Johnson	R.S.Woodworth	L. T. Work	L. T. Work
Chicago	Julius Stieglitz	H. G. Wells	W. W. Watson	M. E. Hanke
Michigan	H. M. Randall	H. E. Lewis	C. E. Guthe	R. C. McAlpin
Illinois	J. W. Lloyd	J. H. Reedy	L. A. Adams	L. E. Card
Case	J. C. Wattleworth	N. A. Lange	C. F. Prutton	T. M. Focke
Indiana	M. E. Hufford	K. P. Williams	W. A. Fletcher	Paul Weatherwax
Missouri	W. A. Westfall	W. A. Albrecht	H. D. Hooker	H. D. Hooker
Colorado	F. E. E. Germann	W. C. Toepelman I. V. Wallin	C. F. Poe	F. S. Bauer
Northwestern	B. J. Spence	A. A. Day	A. J. Walcott	Louise Otis
Syracuse	C. L. Brightman	C. C. Carpenter	P. J. Sedgwick	C. C. Forsaith
Wisconsin	E. M. Terry	.....	E. L. Sevringhaus	H. A. Schuette
University of Washington	J. E. Guberlet	.....	Hewitt Wilson	.....
Worcester	B. E. Fernow	M. E. Smith	H. J. Gay	C. F. Meyer
Purdue	E. B. Mains	R. B. Wiley	W. E. Edington	H. MacGillivray
Washington University	C. Graves	L. Loeb	H. L. Ward	H. M.Miller, J.
District of Columbia	W. T. Lee	E.C.Crittenden	A. E. Eckhardt	M. A. Griffith
Texas	J. M. Kuehne	J. T. Buchholtz	E. C. H. Bantel	H. L. Lochte
Mayo Foundation	T. B. Magath	D. C. Balfour	A. E. Osterberg	A. E. Osterberg
N. Carolina	W. C. Coker	J. F. Dashiell	J. H. Swartz	J. H. Swartz
N. Dakota	G. A. Abbott	George Wheeler	E. A. Baird	E. A. Baird
Ames	P. E. Brown	P.Mable Nelson	J. A. Wilkinson	G. W. Snedecor
Rutgers	J. W. Shive	R. C. H. Heck	W. R. Robbins	T. J. Murray
McGill	A. S. Eve	J. Tait H. M. MacKay	A. Keys	A. Keys
Kentucky	R. N. Maxson	George Roberts	M. N. States	A. C. McFarla
Idaho	I. C. Crawford	T. A. Kostalek	C. W. Hunderford	T. M. Dahm
Swarthmore	C. G. Thatcher	E. L. Mercer	H. J. Creighton	H. J. Creighto
Oregon	H. B. Yocom	O. Larsell	W. P. Boynton	W. D. Smith
Virginia	H. E. Jordan	C. P. Olivier	B. D. Reynolds	B. D. Reynold
Johns Hopkins	B. E. Livingston	K. Dunlap	M. W. Pullen	R. P. Cowles
Calif. Institute of Technology	R. C. Tolman	J. A. Anderson	W. H. Clapp	S. S. Mackeow
New York University	H. D. Senior	R. Mulliken	H. W. Stunkard	H. W. Stunkar
University of Cincinnati	O. C. Von Schlichten	G. D. McLaughlin	S. B. Arenson	S. B. Arenson
Michigan State College	G. W. Bissell	G. H. Coons	R. M. Snyder	J. W. Crist

SIGMA XI CLUBS

Chapter	President	Vice-Pres.	Secretary	Treasurer
Oklahoma	S. Neidman	Bruce Houston	Wm. Schriever	Wm. Schriever
Arizona	G. H. Cresse	E. Anderson	H. B. Leonard	H. B. Leonard
Southern California	Edgar Baruch	R. W. Sorensen	F. J. Smiley	F. J. Smiley
Duluth	.....	.....	E. W. Kelly	.....
Kansas State Agricultural College	G. A. Dean	E. C. Miller	C. W. Colver	C. W. Colver
Carleton College	H. E. Stork	F. F. Exner	C. H. Gingrich	C. H. Gingrich
University of Denver	T. R. Garth	R.E.Nyswander	E. A. Engle	W. H. Hyslop
Oregon State Agricultural College	W. V. Halversen	.....	C. H. Owens	C. H. Owens
Michigan Agricultural College	.....	R. P. Hibbard	R. M. Snyder	R. M. Snyder
West Virginia University	A. M. Reese	J. H. Gill	R. P. Davis	.....
University of Maine	Albert Fitch	J. W. Gowen	Edith M. Patch	Edith M. Patch
University of Pittsburgh	K. D. Swartzel	O.H. Blackwood	Richard Hamer	Richard Hamer
University of Wyoming	Aven Nelson	J. A Hill	O. H. Rechard	O. H. Rechard
University of Florida	G. F. Weber	T. R. Leigh	F. J. Bacon	F. J. Bacon
University of Rochester	J. R. Murlin	.....	H. L. Alling	H. L. Alling
Colorado State Agricultural College	G. T. Avery	L. D. Crain	L. W. Durrell	L. W. Durrell

OFFICIAL ANNOUNCEMENTS

All insignia of the Society are available only through the office of the national secretary. Orders for these insignia are issued through chapter secretaries, and must be **prepaid.** Information about styles and prices may be obtained from chapter secretaries or the national secretary.

PRINTED BLANKS

The General Convention has instructed the secretary to forward to chapters under the following stipulations:

Membership Certificates, stamped with the great seal of the Society. In packages of fifty prepaid, on advance payment of $2.5 for each package. Please specify carefully whether for active or associate members.

Index Cards, provided a duplicate set be sent for the general index of the Society maintained in the secretary's office. Gratis

Chapter secretaries are requested to fill out these cards carefully giving PERMANENT addresses of the members, and return to the national secretary.

A few copies of the Quarter Century Record are available at $2.5 each.

Copies of the Constitution are available at 7 cents each.

SIGMA XI BANNERS

Chapters may obtain Sigma Xi Banners at the following prices

Size 3 x 5—$ 8.00
4 x 6— 12.00
5 x 8— 20.00

CHANGES OF ADDRESS

All changes of address and all other correspondence should be addressed to the secretary of Sigma Xi, Edward Ellery, Union College, Schenectady, N. Y.